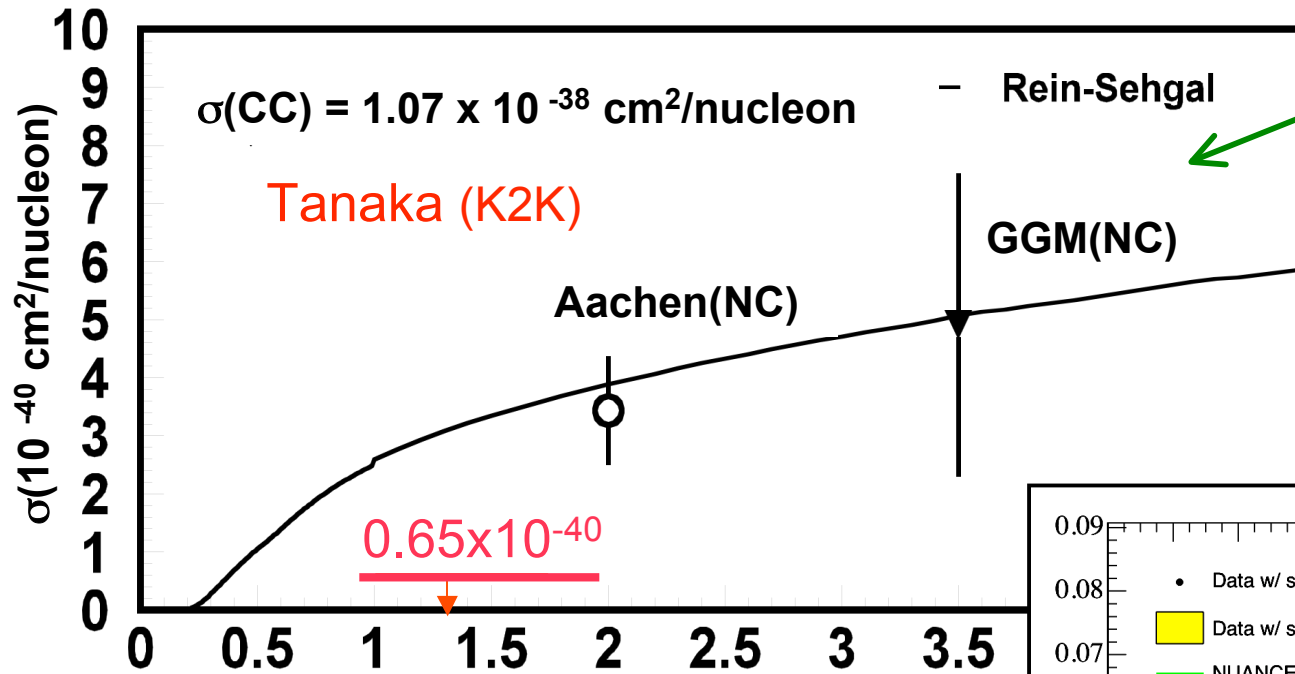# NuInt 05 Session 2
(New Experimental Results)
Summary

Lucio Ludovici
Kevin McFarland
Masoto Shiozawa
Sam Zeller

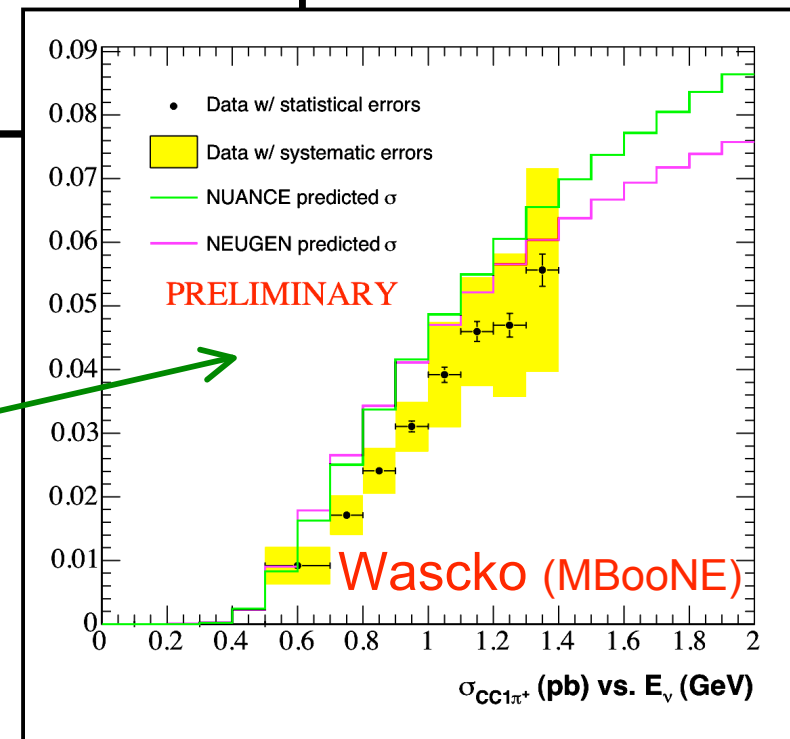# Session 2 Talks
on
Experimental Results

- it is clear that we are learning a lot from new data …

  - in fact, **all** of the talks in session 2 showcased new results/data

In the CC $1\pi^+$ Sector Alone ...

$\sigma(CC) = 1.07 \times 10^{-38}$ cm^2/nucleon

Rein-Sehgal

Tanaka (K2K)

GGM(NC)

Aachen(NC)

0.65×10^{-40}

$\sigma(10^{-40}$ cm^2/nucleon)

1st experimental measurement of coherent π production σ at low energy!

1st measurement of total CC $1\pi^+$ cross section on nuclear target at low energy!

- Data w/ statistical errors
- Data w/ systematic errors
- NUANCE predicted σ
- NEUGEN predicted σ

PRELIMINARY

Wascko (MBooNE)

$\sigma_{CC1\pi^+}$ (pb) vs. E_ν (GeV)
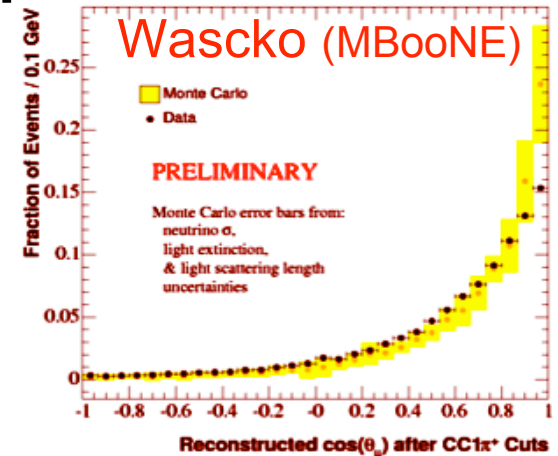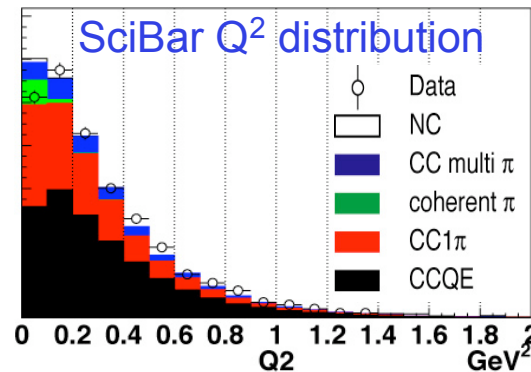
Questions and Requests

- while it is clear that we are learning from this new data

  – this data also raises some new questions
  – we believe many questions can be answered with data, either in hand or soon to be !

- the following are some of the questions & a "wish-list" from your Session 2 conveners for NuInt07 …
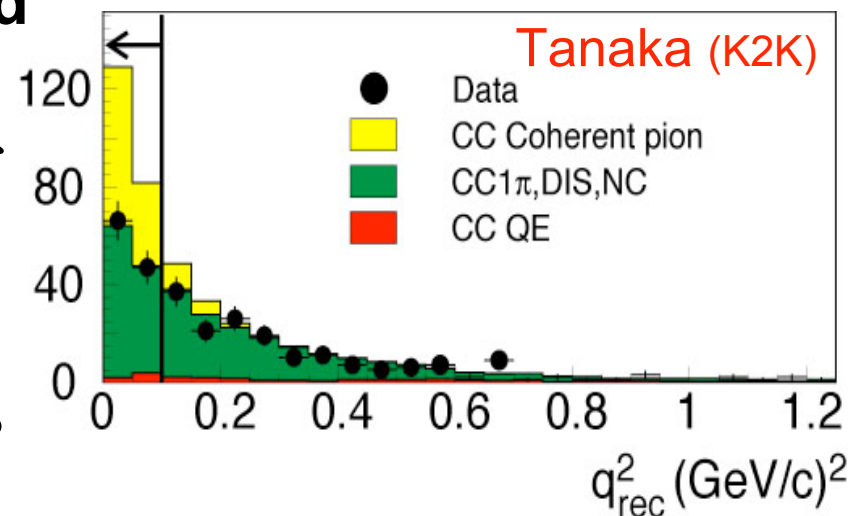
Low Q^2 (Q^2<0.1 GeV^2)

- **low Q^2 deficit seen since start of NuInt !**

  - learned that typically
    larger effect seen
    in 1π (non-QE)
    than in QE

SciBar Q^2 distribution

Data, NC, CC multi π, coherent π, CC1π, CCQE

Wascko (MBooNE)

Monte Carlo, Data

PRELIMINARY

Monte Carlo error bars from:
neutrino σ,
light extinction,
& light scattering length
uncertainties

Reconstructed cos(θ$_\mu$) after CC1π^+ Cuts

- **K2K SciBar results suggest
  little or no CC coherent π^+ prod
  is the explanation**

  - solution for non-QE data
  - what about QE?
   - solves this too since these
      are backgrounds in this sample?

Tanaka (K2K)

Data, CC Coherent pion, CC1π,DIS,NC, CC QE

q^2_{rec} (GeV/c)^2

Questions on $Q^2 < 0.1$ GeV^2...

- **quantitative comparison of low Q^2 behavior in <u>all</u> of our CC exclusive samples on various targets, multiple exps**

  - compare differences between QE vs. non-QE
  - but also CC $1\pi^+$, CC $1\pi^0$, & CC multi-π (ex. shadowing effects larger)

- **nuclear models in current use are deficient?**

  - CC QE and resonance 1π
  - other targets to compare to ^{12}C, ^{16}O; MINOS (Fe)? CHORUS (Pb)?

- **free nucleon: exercise free pars in Rein-Sehgal model**
  - some parameters were set decades ago & what about FFs?
 - test out other models (Sato, Lalakulich/Paschos, Barbaro)

Questions for Coherent π Production

- **can we claim consistency between what we observe in CC π^+ and NC π^0 samples?** (would be a powerful statement)

- **add'l evidence that low Q^2 deficit we observe is truly the result of substantially lower coherent π σ**

  - supporting evidence from other distributions
    - $\cos\theta_\pi$, t (4-mom transfer W, π)

  - cross-check with CC π^0
  (no coherent complications)

  - can MiniBooNE check with $\overline{\nu}$'s?

Wascko (MBooNE)

$\overline{\nu}_\mu$ coherent π^0

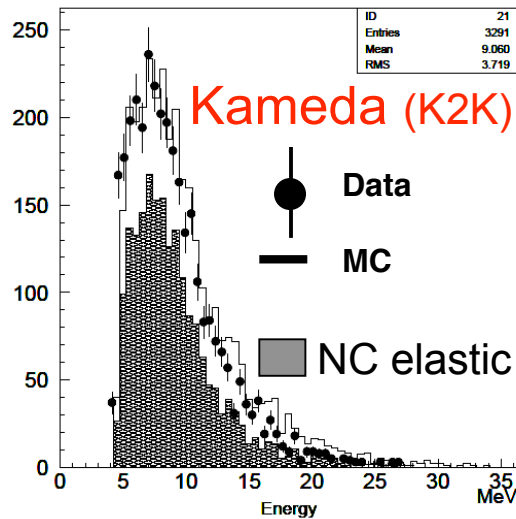$\overline{\nu}_\mu$ resonant π^0

$\cos\Theta_\pi$
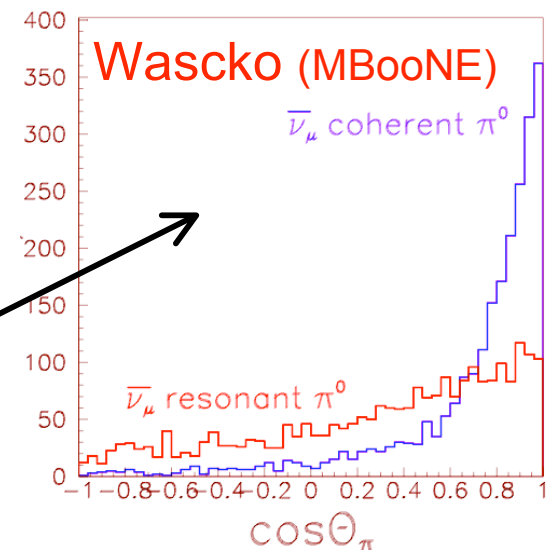
Questions on QE Scattering

- **is our uncertainty on QE σ larger than we thought?**

  - better handle on axial FF with modern, high stat data ("M_A",F_A)
  - how meaningful is difference between K2K & NOMAD M_A?

- **establish common formalism to directly compare results**

  - with best vector FFs, re-evaluate M_A in $\overline{QE}$
    - variety of targets (^{16}O,^{12}C,Fe,Ar?), $\overline{\nu}$
    - also look at $d\sigma/dQ^2$ in CC 1π

  - compare M_A from rates, Q^2 slopes
    - reconsider impact of backgrounds, efficiencies, selection bias

- **nuclear effects**
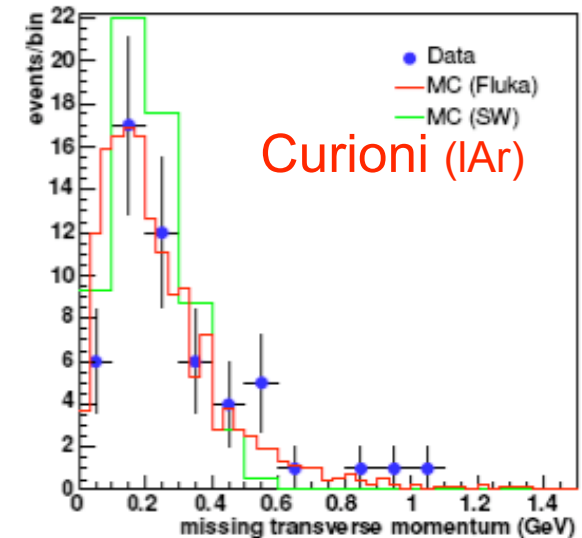 - is there old data from heavy targets to re-fit?

Petti (NOMAD)

Preliminary results
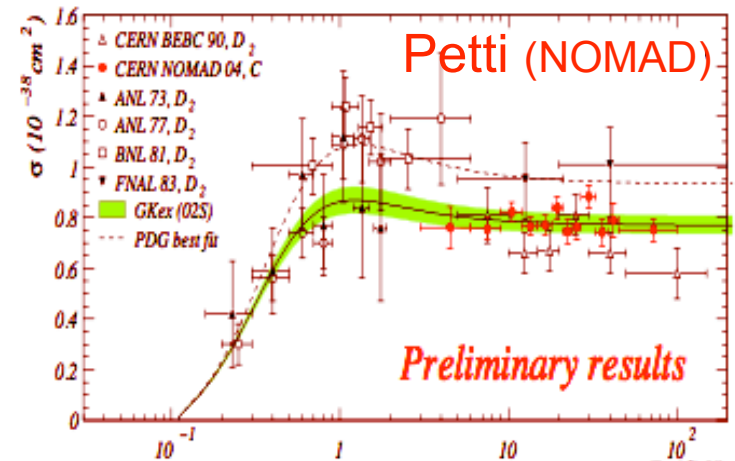
Isolate New Data Samples

(continue to build up body of knowledge)

Kameda (K2K)

- Data
- MC
- NC elastic
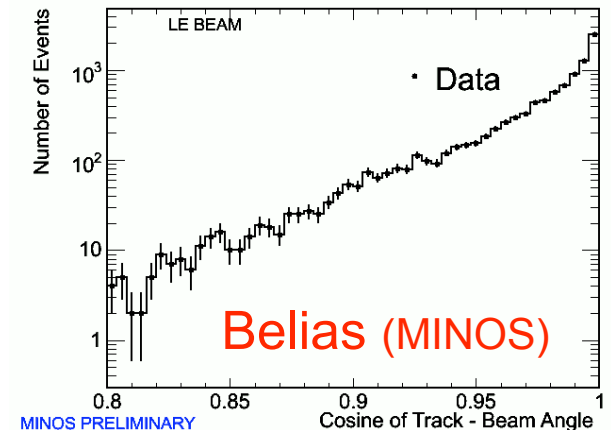

Curioni (IAr)

- **CC 1π^0**

  - test resonance model alone with no coherent

  - disentangle low Q^2 resonant vs. coherent

- **do we have any data on ν_e QE interactions?**

  - $d\sigma/dQ^2$ interesting to check against ν_μ case
  - ν_e events in K2K SciBar
  - MiniBooNE ν_e events from NuMI off-axis?

- **antineutrino data is always welcome!**

Belias (MINOS)

Experimental Data & New Models

- **encourage a continued effort to pit modern ν data (K2K, MiniBooNE, MINOS, NOMAD) against modern models**

    - time to move beyond Fermi Gas & Rein-Sehgal?!
    - have seen many examples here (sessions 4-6)
    - GENIE as means of incorp new models (C. Andreopoulos)

- **experimentalists need code & guidance on how to implement new theoretical predictions**

    - encourage continued communication in this light

Thank You!!

- we would like to thank all of our session 2 speakers

- also, thank Okayama University as well as
  the workshop organizers (Sakuda-san)

    - for hosting this workshop
    - providing support for several of session 2 speakers

Summarize Questions for Discussion

- how well do we understand axial form factors (QE, RES)?

- do we have consistent framework to compare results from different experiments?

- do we really understand what's going on at low Q^2 in all of our data samples?

- do see any potential show-stoppers in incorporating new models into our exp'l descriptions?

- are there other data samples we should be looking at?

- other questions? comments? requests?